Vol. I May, 1916 No. 5

CATALOGUED
JUL 25 1938

MONTHLY BULLETIN

OF THE

OHIO Agricultural Experiment Station

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Monthly Bulletin

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Wheat plots in early May ot the Ohio Experiment Station, showing tenth-acre plots with 2-foot path on each side and 12-foot roadway every tenth plot

MONTHLY BULLETIN

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Ohio Agricultural Experiment Station

VOL. I MAY, 1916 No. 5

WOOL STUDIES[1]

WASHING BEFORE SHEARING—TIME OF SHEARING

J. W. HAMMOND

The practice of washing sheep was at one time rather general in Ohio; and, while it has become obsolete in the greater part of the State, it still persists on many farms in the southern and eastern counties. The following pages report the results of an experiment conducted by the Ohio Experiment Station, in cooperation with A. O. and Howard J. Campbell, of Barnesville, to secure data concerning the utility of this practice. The experiment also yielded some information concerning the advisability of shearing sheep early or late in the spring.

Early in March, 1911, 100 lambs were purchased and divided into four similar lots. The experiment extended over a little more than 3 years, so that during its progress three clips of wool were removed, in 1911, 1912 and 1913. Each lot was shorn as nearly as possible on the same day each year, so that with the exception of the 1911 clip the fleeces removed represent a variation of not more than 2 days from a year's growth. The treatment of the lots with respect to washing and shearing was as follows:

Lot 1. Washed; shorn about April 12.
Lot 2. Unwashed; shorn about April 12.
Lot 3. Washed; shorn about June 1.
Lot 4. Unwashed; shorn about June 1.

The sheep used in the experiment were practically purebred Merinos, of the Delaine type. They had very dense fleeces which carried an unusually large amount of yolk for sheep of this type. They were exceptionally strong and rugged in constitution and were

[1]Extract from Ohio Agr. Exp. Sta. Bul. 294.

perhaps above the average with regard to weight and quality of fleece. The sheep are managed with the object of keeping them in a healthy, growing condition rather than of fattening them.

Each sheep was washed separately in a stream, and an attempt was made to do a thorough job, but, because of the density of the fleeces and the large amount of yolk they carried, it is probable that the washed wool still contained more foreign matter than is contained in washed wool from more open-wooled sheep.

INFLUENCE OF WASHING BEFORE SHEARING

On yield of grease and of scoured[1] wool.—Table I shows the average yield per head of grease wool and of scoured wool produced by each lot of sheep for the 2 years, 1912 and 1913, and the percent of scoured wool. This table shows that the loss in weight of fleece depended somewhat upon the time of year when the washing was done. When the sheep were washed, and then shorn April 12, there was a loss of 1.49 pounds per fleece due to washing; but when they were washed, and then shorn June 1, this loss was 2.64 pounds per fleece. Table I shows, however, that the yield of *scoured* wool was practically the same for the washed and for the unwashed sheep, the difference being too small and irregular to indicate that washing the sheep was detrimental to the growth of the wool.

TABLE I.—Average yield per head of grease and of scoured wool (1912 and 1913)

	Lot 1 Washed Shorn April 12	Lot 2 Unwashed Shorn April 12	Lot 3 Washed Shorn June 1	Lot 4 Unwashed Shorn June 1
Grease wool.....pounds..	10.33	11.82	9.89	12.53
Scoured wool.....do.....	3.86	3.87	3.62	3.79
Scoured wool.....percent..	40.63	36.56	38.65	32.96

This table shows, as would be expected, that the grease wool from both lots of sheep that were washed yielded a greater percent of scoured wool than did the grease wool from the two lots that were not washed. The difference between washed and unwashed wool, with respect to the yield of scoured wool, was greater in case of the wool shorn June 1 than in case of that shorn April 12.

Since Table I shows a difference between washed and unwashed sheep with respect to the yield of grease wool, the question naturally arises: "Does the grower receive sufficient premium for washed

[1] *Scoured wool* is wool from which such impurities as yolk, sand, etc., have been removed by the process known as *scouring*. *Grease wool* is wool as it comes from the sheep, whether or not it has been washed.

wool to repay him for the loss in weight due to washing and for the cost of washing?" Since the table also shows a difference between washed and unwashed wool with respect to the yield of scoured wool, another question arises: "What are the relative values of washed and unwashed wool to the manufacturer?" In answering these questions it should be said that it is extremely doubtful if washing sheep is in any way beneficial to the manufacturers. Even if the sheep are washed before shearing, the wool must be scoured before it can be used, and the washing in no way lowers the cost of this process. The manufacturer attempts to buy washed and unwashed wool at the same price on a scoured-wool basis. Table II shows the corresponding prices the manufacturer could have afforded to pay for the washed wool produced in this experiment with unwashed wool worth the prices indicated, and have each class of wool cost him the same on a scoured-wool basis. This table is computed from the average yield of scoured wool from each lot of grease wool for the years 1912 and 1913, as shown in Table I. Since not all wool, whether washed or unwashed, will shrink the same as that from the the sheep used in this experiment, Table II should not be expected to show the exact relationship between the value of washed and unwashed wool that exists in all cases.

TABLE II.—Comparative values of washed and unwashed wool (cents)

Based on sheep shorn April 12			Based on sheep shorn June 1		
When unwashed wool is worth the following prices per pound	Washed wool should be worth the following prices per pound	Premium which washed wool should command over unwashed wool	When unwashed wool is worth the following prices per pound	Washed wool should be worth the following prices per pound	Premium which washed wool should command over unwashed wool
20	22.23	2.23	20	23.45	3.45
22	24.45	2.45	22	25.80	3.80
25	27.78	2.78	25	29.32	4.32
27	30.01	3.01	27	31.66	4.66
30	33.34	3.34	30	35.18	5.18
33	36.67	3.67	33	38.70	5.70

The data presented in Table II offer but little encouragement for the wool grower to wash his sheep before shearing. By means of the scale of prices given in this table the grower is able to tell pretty closely whether the premium offered for washed wool is sufficient to repay him for the loss in weight due to washing. The figures given in Table II make no allowance for the cost of washing. One thing that should be kept in mind is that the sheep used in this

experiment carried denser and more oily fleeces than are carried by the average sheep of the State; consequently, the washed wool shrank more in scouring. This results in a smaller "spread" in the prices for washed and for unwashed wool than would be expected in the case of more open-wooled sheep. On this account, Table II shows approximately the minimum premium for washed over unwashed wool which the grower can afford to receive and secure the same for his wool, on a scoured-wool basis, as he would secure if the wool is not washed, when no allowance is made for the cost of washing.

In sections of the State where sheep are washed, they are usually washed and shorn in May or early June; therefore, that part of Table II which deals with the sheep washed in June is perhaps the more nearly applicable to the sheep-washing proposition in Ohio. A comparison of these figures with actual market prices reveals the fact that the relationship between the prices of washed and of unwashed wool shown in Table II is very close to that which actually exists. These figures indicate that the man who washes his sheep usually does not receive a price for his wool which is sufficient to pay him for washing, a task which is not only difficult and unpleasant, but which carries more or less danger both to the flock and to the owner.

Table I shows that when the sheep were washed and shorn about April 12 there was not as great a loss from washing as resulted when the sheep were washed and shorn about June 1; consequently, a smaller difference in price in the grease wool is necessary to keep washed and unwashed wool on a par, on a scoured wool basis. This is illustrated in Table II. This fact cannot be used as an argument in favor of washing sheep at such times of the year or in such a manner as will result in the wool being poorly washed, with the intention of selling the wool at prices which are paid for wool that is properly washed. It should always be kept in mind that dealers and manufacturers know more than does the grower about the value of wool; and, if such practices as have just been described are followed generally enough to increase the average amount of shrinkage of washed wool, it is almost certain that manufacturers will lower the price paid for washed wool so that it will be in keeping with the true value of the wool.

On rate of gain.—The sheep were weighed at various intervals after washing and shearing, and there was practically no difference between the washed and the unwashed sheep with respect to the gains made. There was no evidence to indicate that washing was in any way injurious to the sheep.

INFLUENCE OF THE TIME OF SHEARING

On yield of grease and of scoured wool.—There is a belief on the part of many sheepmen that the coming of warm weather results in the presence of more yolk in the fleece, and a corresponding increase in its weight. It is because of this belief that many sheepmen do not like to begin shearing until the weather becomes warm enough to "bring out the grease." The data presented in Table I furnish evidence to justify this belief. This table shows that the washed sheep shorn June 1 produced more grease wool per head than did those shorn April 12, but with an actual decrease in the amount of scoured wool; indicating that between the dates mentioned there was an increase in the proportion of matter other than wool fiber in the fleeces. The difference in favor of early shorn wool with respect to the yield of scoured wool was almost twice as great in case of the unwashed as in case of the washed wool, indicating that this additional amount of foreign matter was partly, but not entirely, removed when the sheep were washed. The yield of grease wool, however, should not be the only thing considered in connection with the time of shearing. Attention is called to the fact that both lots of sheep shorn April 12 yielded more scoured wool per head than did the lots shorn June 1. While this difference of a fraction of a pound per head of scoured wool seems slight, yet, when scoured Delaine wool is worth from 60 to 80 cents per pound, or even more, it may be seen that the difference is of no small financial consequence in a large flock. This point, however, will have but little practical bearing until there is evolved a system of buying wool which will take the amount of shrinkage into consideration more than does the present system and make it possible for growers to receive prices that are more nearly in keeping with the real value of their wool.

On rate of gain.—It is commonly admitted, even by those who favor late shearing because of the greater weight of grease wool secured, that sheep will thrive better and make larger gains if they are shorn before hot weather comes in the spring. The results of the experiment furnish evidence to substantiate this opinion. While these differences in rate of gain are not large, they favor shearing early enough to avoid hot weather in the spring.

Other things, not shown in this experiment, in favor of early shearing are the avoidance of much of the trouble from maggots, which is likely to result if the sheep are not shorn until late in the spring, and the elimination of "tagging" the sheep to prevent the wool around the breech from becoming soiled when the sheep are turned to pasture.

THE COST OF TILE DRAINAGE ON THE TRUMBULL COUNTY EXPERIMENT FARM

H. L. ANDREW

Operations on the Trumbull County Experiment Farm were commenced in the spring of 1915. The greatest need of the farm was tile drainage, and hence a complete system was started soon afterward. The Ohio Experiment Station ditcher was not available then, but, in order that plot and field work could be started as quickly as possible, another power ditcher was secured. The land on this farm is a heavy clay soil with many rocks in it, which at times make operations with the machine troublesome. The topography of the farm is rather level.

The rainfall in this section of the county averages about 28 to 30 inches annually. In 1914 the greatest rainfall was in the months of April and August, when the mean was about 5.7 inches.

THE DRAINAGE SYSTEM

Laying out the system.—The drainage system was laid out in a systematic way, the location of the mains being determined by the lay of the land. An open ditch across the farm made few mains necessary in comparison with the number of tile laid. The laterals were laid the length of the field, the watershed determining to which main or submain the water drained in case there was more than one slope.

The distance between laterals varies somewhat. In plot work, where the laterals were laid in the same direction as the plots, the distance apart is 36 feet, so that there is a drain on one side of each plot. The remainder are from 33 to 40 feet apart, all the laterals in the field work being placed 40 feet apart. The depth of drain averages about 30 inches for the whole system.

The time recorded for laying out the system of 110 acres was approximately 44½ hours, which at 20 cents per hour totals $8.90.

Size of tile.—None of the tile were more than 7 inches in diameter, most of them being 4 inches. The following table gives the size and number laid.

TABLE I.—Size and number of tile

Size .....inches	3	3½	4	5	6	7	
Number	7,184	5,000	103,093	3,883	3,710	671	
Total							123,541

Overrun.—It was found that the overrun in the tile averaged between 5 and 6 percent, and that the extra tile just about equaled the breakage.

Hauling tile.—In this particular case hauling the tile was an important item. The tile were hauled distances as shown in Table II, which also gives hauling costs.

TABLE II.—Cost of hauling tile

Distance hauled	Tile hauled		Total cost of hauling	Cost of hauling a rod one mile
	Number	Length		
		Rods	Dollars	Cents
2½ miles	17,400	1,054.54	457.29	0.013+
8 miles	27,991	1,696.43		
4 miles	78,150	4,736.36		
Total or average	123,541	7,487.33	457.29	0.013+

The cost of hauling for the different distances was not kept separate, and hence only the total cost for all distances can be given. The cost of hauling will vary under different conditions, but the

Cutting trenches with the Experiment Station ditcher

table gives some idea as to this cost when one knows the number of rods to haul and the distance of hauling, especially if the approximate distance is 4¾ miles. In this work most of the tile were

hauled with teams directly to the field and scattered. The cost of labor per hour was figured at 20 cents for man 10 cents for horse and 22 cents for the tractor.

Cutting trenches.—The trenches were all dug by a machine ditcher, except where it was impossible to go with it. Part of the trenches were cut at contract prices, while the rest were cut with the Experiment Station ditcher. However, the work done with the Station ditcher was figured at the same rate as that for contract labor. A total of 7,959 rods of ditch was cut, which at 30 cents a rod (a rate of 1 cent per rod for each inch in depth) would give a total cost of $2,387.70, or $21.71 per acre.

Laying tile.—Part of the tile were laid by contract on a rod basis; the rest, at an hour rate. The contract price was 6 cents per rod, which included finishing the trenches where the machine could not go, as for example under fences and where the laterals joined the mains. The cost of finishing the ditches and of laying the tile is given in Table III.

TABLE III.—Cost of finishing ditches and laying tile

	Length of ditch	Cost per rod	Total cost
	Rods	Cents	Dollars
Contract labor	2,052	6.0	123.12
Farm labor	5,907	1.8	106.40
Total	7,959	.....	229.52

Filling ditches.—The operation of filling ditches was accomplished partly by horse power and partly by hand. Also, 1,953 rods was filled at a contract price of 4 cents per rod. Part of the filling was done with a slush board. This method of drawing the dirt into the ditches was not as successful as when a homemade King drag, 16 to 18 feet long, was used. A team hitched to each end pulling it at an angle scraped the dirt into the trench quite rapidly. Three or four times along the trench usually filled it. The cost of these operations is given in Table IV.

TABLE IV.—Cost of filling ditches

	Length	Cost per rod	Total cost
	Rods	Cents	Dollars
Contract labor	1,952	4.00	78.08
Farm labor	6 007	1.59	95.40
Total	7 959	....	173.48

Here the contract price is much higher than the farm labor cost. There was little or no trouble encountered by trenches caving in. However, the laying was kept just behind the machine so that rain could cause no dirt to fall into the trenches before the tile were laid.

SUMMARY

The cost of tiling the 110 acres is given in Table V as folows:

TABLE V.—Summary of tile-drainage costs

Cost	Staking	Machine work cutting trenches	Hauling tile	Laying tile	Filling ditches	Tile	Total
Total cost.....	$8.90	$2,387.70	$457.29	$229.52	$173.48	$1,886.97	$5,137.86
Cost per rod...	.0011	.3000	.0574	.0287	.0220	.2363	.6455
Cost per acre..	.08	21.71	4.15	2.09	1.58	17.04	46.63

The contract labor may seem to make the cost of ditching higher than it should be. The limited time during which a machine can be used in a year of necessity raises the price of contract work.

Filling ditches on the Trumbull County Experiment Farm

If we may use the data reported in Circular 147 of the Ohio Station, an interesting fact is brought out. In that report the cost of operating the machine, including the operator's wages, repairs, oil, gas and interest—everything except depreciation—was 15.39 cents, or about half the contract price in Trumbull County. On this basis, had the machine for the work in Trumbull County been bought and worn out when the 7,959 rods of ditch was cut, the cost of cutting

the trenches would have been $2,845.91. As a matter of fact, ditching machines will cut from 100 to 200 miles of trench, while the amount reported here is only about 25 miles.

Of course, it would not pay a man to buy a traction ditcher if he had only a few acres to drain. Still, in the case of draining a whole farm, as is needed in many sections of Ohio, the question arises whether it would not be more economical to buy a power ditcher than to have the work done by contract, by plow ditcher, or by hand.

The facts above go to show the possibilities of several farmers, or even improvement associations, buying machines to do their work at a greatly reduced cost. The writer knows of one machine where, after considering its cost, the operating expenses and the like, the cost per rod was about 11 cents, figuring that the machine was worn out when the work was done, but as a matter of fact the machine was sold for $200. A traction ditcher of the type used on the Trumbull County Farm can be purchased for from $1,200 to $1,400 and will do practically all the ordinary farm trench cutting. If the price of cutting had been reduced from 30 cents to 15 cents, as might be done if several men together purchased a machine, the cost of the system in Trumbull County, other items being equal, would have been as follows: Total cost $3,944.01; cost per rod 0.4955 cents; cost per acre $35.85.

While the figures from this farm are not entirely applicable to the various conditions in all counties of the State, still they will fit the circumstances in many cases and will serve as an index to relative costs in most sections.

CAN WE AFFORD TO OMIT THE POTASH?

In the 5-year rotation at Wooster, acid phosphate, used alone, has increased the value of the crops, as a 20-year average, by $2.78 annually over the cost of the fertilizer. When a complete fertilizer has been used the increase has been worth $2.87 more than the cost of the fertilizer. Even at the prices of nitrogen and potash in fertilizers before the European war, therefore, there has been a very narrow margin in favor of the complete fertilizer, and under present conditions farmers are advised to purchase only acid phosphate and steamed bonemeal, and to depend upon clover and manure for nitrogen and potash.

HEAVY SILAGE VS. HEAVY GRAIN FEEDING FOR DAIRY COWS[1]

C. C. HAYDEN

During the winter and spring of 1904, C. G. Williams, agronomist of the Station, conducted an experiment to determine the advisability of feeding more silage and less grain to dairy cows than is commonly fed. Eight cows were used in the experiment and divided into two lots of four each, although only five were retained throughout the entire test. The test began January 1 and closed April 30, 121 days.

Rations fed.—The silage used in the test was composed of corn, soybeans and cowpeas in about the following proportions: 7½ tons of corn, 2 tons of soybeans and 1 ton of cowpeas. The addition of the soybeans and cowpeas made the silage richer in protein than corn silage alone. The percentage of dry matter in the silage as it went into the silo was 18.63 percent, which is low when compared with that of silage from well-matured, well-eared corn, which often contains as high as 30 percent of dry matter. The high water content of the silage had an important bearing on the total water consumed by the cows in this test.

A ration consisting of about 58 pounds of silage, 6.8 pounds of mixed hay, 2 pounds of linseed oilmeal and 2 pounds of wheat bran was compared with a ration containing 4.7 pounds of corn stover, 6.4 pounds of mixed hay, 2.5 pounds of linseed oilmeal, 5 pounds of cornmeal and 6 pounds of wheat bran. The former will be called the silage ration and the latter, the grain ration.

It will be noted that the silage ration contained but 4 pounds of grain other than that contained in the silage, while the grain ration provided 13.5 pounds of grain. The object of the experiment was to determine whether the silage could take the place of the extra amount of grain, and make it necessary to feed, in connection with silage, only small quantities of grains high in protein.

The amount of dry matter in the silage ration was 20.16 percent and that in the grain ration, 20.51 percent, making the dry matter practically equal in amount in the two rations. In the silage ration, 82 percent of the dry matter was supplied by roughage, while in the grain ration only 43 percent of the dry matter was thus furnished. It is commonly considered that the dry matter in grain is more digestible, and hence is more efficient, than in roughage. This

[1]Extract from Ohio Agr. Exp. Sta. Bul. 155, *Silage vs. grain for dairy cows.*

does not seem to prove true in this case, if we consider silage to be roughage. Strictly speaking, it is both grain and roughage especially when made from well-eared corn.

The silage ration contained 48 pounds of water; the grain ration, 4 pounds. Still the cows on the former ration each drank 45 pounds of water daily and those on the latter ration, 65 pounds. This, together with that in the rations, made a total daily consumption of 93 pounds and 69 pounds of water, respectively. The cows on the silage ration thus consumed 24 pounds more water daily.

Furthermore, the two rations contained practically the same amount of digestible nutrients, acording to Henry's tables. The great differences between the two rations, therefore, were the proportions of grain and the quantity of water consumed. Was the dry matter in the corn-soybean-cowpea silage more digestible than that in the stover and grain of the grain ration? The following results in production indicate that it was more effective or that the extra water caused the entire ration to be more effective.

Results.—Previous to the test, the cows which later received the silage ration were producing 9.4 percent more milk and 8 percent more butterfat than those which received the grain ration. During the test, the silage-fed cows produced 17 percent more milk and 28.4 percent more fat than the other lot. This was a gain of 7.6 percent in milk and 20.4 percent in fat in favor of the silage ration.

The cows on the silage ration gained in weight an average of 47 pounds while on the test and those on the grain ration, an average of 57 pounds. a difference of 10 pounds in favor of the grain ration.

The feed cost of the production of 100 pounds of milk with the silage ration was 69 cents and with the grain ration, $1.05. The feed cost of a pound of butterfat with the silage ration was 13 cents and with the grain ration, 22 cents. The prices of feeds per ton were as follows: Silage $2, hay $10, corn stover $4, wheat bran $18.74, cornmeal $20, and linseed oilmeal $23.25. At present these prices would be unusually low except perhaps for the hay and stover. However, the change in prices would not greatly affect the relative results, though it would increase considerably the cost per unit of product.

One lesson to be drawn from this test is that home-grown feeds should be used as far as possible. Carbohydrate feeds can usually be grown more cheaply than those purchased, and only the feeds high in protein need be bought if they cannot be grown on the farm. A second lesson is that a succulent feed which causes the cow to consume more water in winter is valuable.

FRUIT-BUD FORMATION ON APPLE TREES

A. D. SELBY

The formation of fruit or blossom buds upon bearing apple trees takes place normally the season preceding the fruit crop from these buds; the exception is found in occasional blossom clusters in summer or fall. Similar conditions hold true for fruit-bud formation upon peach, plum and pear. Realizing that fruit-bud formation must commonly take place along with crop bearing and maturity, one will readily see the importance of the mutual influences. The actual period of fruit-bud formation upon our winter apple varieties is subject to many influences; of these, certain factors are less clear than others. We observe decided differences in the amount of bloom as between different seasons. The habit of certain varieties is described as bearing annual crops or biennial crops. The biennial crop sorts produce fruit buds chiefly in the off crop year. When we are speaking about fruit-bud formation in the present discussion, we deal with varieties having the annual crop habit.

TIME OF FRUIT-BUD DEVELOPMENT

The usual fruit-bud development begins at or near the close of a growth period. There is evidently greater activity of this kind at the close of the early season's growth, which takes place very largely from the stored plant food of the trees. The conditions of the supply of moisture carrying plant food and the aeration of the soil on the one hand, against the demands made upon the tree by the blossoming and fruit crop of the season on the other, appear to be dominant factors. Aeration of the soil is mentioned to guard against hasty inferences based upon possible excess of water. It appears that in 1915 the conditions were exceptionally favorable for bud formation under the moderate rainfall of the latter part of May and the liberal rains of June. This applies especially to southern Ohio, where some observations made June 10-12 indicated very abundant bud formation in the location of fruit buds; actual later season conditions may be conceived as restricting the development of the parts of the blossoms, though none apparently occurred in the later season of 1915. The season of 1916 offers a full opportunity to note the outcome when the conditions throughout the bud-forming season, with the possible exception of leaf diseases, insects and the like, were continuously favorable.

POSSIBLE DANGERS IN 1916

Granting that with the abundant rains, etc. of 1915, fruit-bud development was possible in the later season as well, what may we expect of 1916? There may be real dangers under the stress of excessive blooming and fruiting, or of a critical drouth period, such as often occurs in the southern section of Ohio, or of both combined. Under such an emergency the insurance of the moisture supply with plant food for late May and June appears to offer a means of providing for fruit-bud development. The very great influence of such moisture insurance at that time seems well demonstrated. The dominant character of similar action at another time during the season has not been clearly demonstrated. The lesson offered is the early provision for the moisture-food supply in this period to aid fruit-bud development for 1917. The matters for which the grower would seek to care in 1916 are, for sod culture, the early applications or restorations of the mulches about trees, together with the early application of the fertilizers to be used, so that these may be associated with a supply of moisture; also the early cutting of the cover crop will guard against its using moisture needed by the trees. The actual time of the earlier fruit-bud development in average seasons is sufficiently late to make early cover-crop removal of value. For cultivated orchards the principle, rather than the actual practice methods, will apply.

Another lesson may relate to possible blossom-cluster removal at this or a later period, but such clipping or pruning of fruit clusters offers too serious practical difficulties for the owner of the large orchard. As yet, thinning of the fruit has not provided for fruit-bud development where the other early conditions have been lacking.

WHAT IS ACID PHOSPHATE WORTH?

In the average of 22 years work at Wooster, 21 at Strongsville and 12 years at Germantown and Carpenter, acid phosphate, used at the rate of 80 to 120 pounds per acre, has returned a little more than 8 bushels of corn for 100 pounds of phosphate, the fertilizer being spread on all the land with the grain fertilizer drill just before planting the corn.

CONTROLLING THE GRAPE-BERRY WORM[1]

W. H. GOODWIN

The control of the grape-berry worm was first studied by the Ohio Experiment Station in 1906 at North Bass Island. These studies were continued in 1907-09 and later in 1913-15, mainly in the Lake Erie section, which is the region of greatest infestation by the insect in the United States. It will be the purpose of this article to give briefly the recommendations for the control of the insect from the observations made during these years.

Early work.—In the first experiments three sprayings were made during the season: the first application just before the grapes bloomed; the second when the grape berries were about as large as peas, or about three-sixteenths of an inch in diameter; and a third about mid-July. At Kelley's Island in 1907 applications of arsenate of lead, Bordeaux and soap produced the largest crops of sound grapes. The 1908 experiments at Euclid were not as successful in berry-worm control, but the results indicated a similar conclusion. Three pounds of paste arsenate of lead, 3-4-50 Bordeaux and one pound of dissolved soap applied in each of three sprayings destroyed most of the berry worms.

Grape-berry worm and moth
(6 diameters)

In 1909, 1 gallon of commercial lime-sulphur and 3 pounds of arsenate of lead paste to each 50 gallons of water was tested in comparison with arsenate of lead, Bordeaux and soap. The dilute lime-sulphur and arsenate of lead spray defoliated most of the vines and ruined the crop of grapes wherever applied. Several cases of similar injury have come to the author's attention during the seasons of 1914 and 1915.

[1]Extract from Ohio Agr. Exp. Sta. Bul. 293.

Life history studies of the berry worm were begun in the fall of 1912 in order to determine the habits and number of broods of the moth during the year in northern Ohio. A program of control measures based on previous experimental work was then followed. The life history studies of 1913 indicated that the third spraying (July 10-15) was applied almost a month before the eggs of the second, or August, brood of moths hatched. The poison spray certainly could not remain effective for a period of 4 to 6 weeks, especially when the grape berries were increasing in size very rapidly. Hence, it did not prevent the second brood of berry worms from injuring a large part of the grape crop. The three sprayings were made during the time when the worms of the first brood were developing, and failed to kill a large number of them.

Cocoons of grape-berry worm on grape leaves
Life-size moth below

In 1914 the third application was not applied until July 28 to 31, which was just as the moths began to appear. The moths did not begin to lay their eggs for 3 to 4 days after they emerged. The eggs hatched in 3 to 5 days, so that the third application of spray might have been applied about 5 days later. Still, the best plot had less than 1 percent wormy berries in the latter part of September.

Catawbas sprayed with arsenate of lead, Bordeaux and soap, 1915

Unsprayed Catawbas, 1915

Vineyards thoroughly sprayed by members of the Dover Fruit Growers' Association from August 1 to 10 had only 2 to 3 percent of wormy berries wherever the spraying had been carefully and thoroughly done and a sufficient amount of spray applied. Combinations of arsenate of lead in different amounts, with soap, Bordeaux, Bordeaux and soap, copperas and nicotine sulphate were used in spraying these test plots.

Spraying program.—In 1915, experiments at Euclid, Dover and Sandusky, Ohio, were conducted in order to test thoroughly the control measures by which the best results were obtained in 1913 and 1914. At Euclid a number of plots were sprayed with different amounts of arsenate of lead in combination with soap, and with 2-3-50 Bordeaux and soap. Only two applications of spray were put on, as the experiments of 1913 and 1914 indicated that the spraying before bloom was of little value in controlling the berry worm. Good results were obtained by thorough spraying when the largest grape berries were about one-eighth inch in diameter and again between 5 and 6 weeks later. For the first spray 4 pounds of arsenate of lead paste with Bordeaux 2-3-50 and 2 pounds of dissolved soap should be used.

The second spray is applied about 7 weeks after the grapes bloom, usually about August 3 to 12, which time just precedes the placing of the eggs on the grape berries and stems by the second-brood moths. Use arsenate of lead paste 4 pounds, Bordeaux 2-3-50 and dissolved soft soap 2 pounds, covering every bunch thoroughly, making the application by hand, preferably by the trailer method. Applications of spray at other times have not been of much value in controlling the insect.

A large vineyard at Sandusky thoroughly sprayed by hand from the 3d to 18th of August matured an excellent crop of grapes. An unsprayed vineyard on the same place and adjoining unsprayed vineyards were so badly injured by the berry worm that they were scarcely worth picking. In part of the vineyard sprayed with Derror's Tree Fluid, the crop was practically ruined.

Clean cultivation.—Gathering the berry-worm cocoons which are on the leaves anchored in the soil in October, just before the frost brings all the grape leaves down, will help to reduce the number of berry worms the next summer. Plowing in the latter part of May will bury some of the cocoons so deep that the moths cannot get out. Heavy applications of manure, cultivation, soil conservation by the use of cover crops and pruning will increase the yield. These measures, together with thorough spraying with the right materials at the proper time, will practically prevent berry-worm injury.

THE YELLOW LOCUST (*Robinia pseudacacia*)

J. J. CRUMLEY

The natural habitat of the locust embraces both slopes of the Appalachian Mountains from Pennsylvania to Georgia, extending westward far enough to include considerable portions of Ohio, Kentucky and Tennessee. It was found also in Arkansas and Oklahoma by the first white settlers in that part of the country, though it may have been carried to that western site by the Indians, who used it for bow wood.

Influence of topographical conditions.—The locust is distinctly a tree of the hills and will not endure a cold, wet soil. The Experiment Station made an extensive experimental planting with this tree on the Oberlin waterworks farm in the spring of 1905. The soil there is cold and rather wet, and the entire locust planting is practically a complete failure. The same thing has been regularly observed in other plantings over the State. The tree shows a marked indifference to soil fertility under certain conditions. It will flourish in a pure clay subsoil from which the entire top soil has been washed off, where corn would not grow more than a foot tall. This is a very important characteristic, since it fits the tree so well for the purpose of reforesting worn-out lands and areas where the soil has been carried away by erosion; and such areas are most likely to be found on the type of land, topographically speaking, well suited for the locust.

Belongs to the legumes.—It may be mentioned in this connection that the locust tree belongs to the family of legumes, and will develop nodules of bacteria on the roots the same as the clovers. Where it is planted or springs up by natural regeneration on a barren clay knoll, it restores the fertility to such an extent that after a single crop of trees the ground would again grow good corn and other agricultural crops. The accompanying illustration shows a grove of locust trees 22 years old that came up on a knoll, which through unwise cultivation and by erosion had been so exhausted of fertility that it would no longer produce crops worth the work expended on the ground, and the plot was abandoned. The ground is now fertile and would produce good corn and other agricultural crops. Not a pound of fertilizer has been put on it during these 22 years. There are 30 or 40 acres of land on this same farm which have passed through the same two stages of existence. The soil

instead of being hard and dead is now loose and lively. It is extremely interesting to see how bluegrass in some places and blackberry briars in others thrive under these locust trees and after the trees are cut, and that the grass and briars are not found on adjoining plots still barren where the locusts have never got started.

Intolerant of shade.—The locust will not thrive under much shade, being one of the most intolerant trees in the State. Where it comes up naturally or is planted in pure stands, it will, in a certain sense, not make use of all the light over the area, as compared with what certain other trees would do. In a grove of locusts where the stand is complete, other shade-enduring trees may spring up and thrive beneath the crowns of the locust. For example, on the area shown in the illustration, a little hickory seedling sprang up a few years ago and is flourishing in the midst of scores of little locusts that died for the want of light. This hickory is now 15 feet tall and can be noticed in the right of the picture.

Size and early maturity.—The locust does not reach the giant proportions attained by the oak, the walnut or the tulip poplar; but it grows to maturity in much shorter time than these trees. A locust 18 inches in diameter is as much a mature tree as a 4-foot white oak. Its early maturity and the fact that posts can be cut from trees of small size make the locust attractive to prospective planters, for it enables them to reap an income at a comparatively early date.

Durability of the wood.—The wood of eight different species of trees is used extensively in Ohio for posts. The locust ranks second in this list, being surpassed in durability only by Osage orange. These eight timbers in their relative order are as follows: Osage orange, locust, red cedar, mulberry, white cedar, catalpa, chestnut and oak. (See Ohio Agr. Exp. Sta. Bul. 219.)

The durability of the wood is plainly affected by two conditions, soundness and the rate of growth. The durability is in direct proportion to the soundness and in indirect proportion to the rate of growth. Only sound wood, of course, is supposed to be made into posts, but timber to be used in the ground demands a different degree of soundness from that used for most other purposes. The wood of the locust may be solid and tough and yet be in a process of decay that would cause it to rot soon if put in the soil. This quality of wood may be known by a characteristic dull brown color, while the healthy wood possesses a yellowish straw color.

Let me suggest to the prospective purchaser, that if most of the rings on the posts are a quarter of an inch thick, the posts are of

doubtful value; and if they reach the thickness of a half-inch or more, regardless of color or soundness, they should not be purchased.

Natural regeneration of locust trees on land abandoned 22 years ago for agricultural purposes

Production and market value.—The trees shown in the illustration furnish some rather interesting figures with regard to the production and market value of the locust. Since the picture was made these trees have been cut into fence posts and put on the market. It cost but 6 cents a post to cut, haul and put them on the car 1½ miles from the grove. They were sold on the car at that point at 17 cents, thus leaving 11 cents a post net, that is, clear of all expense incurred from the tree to the market. The posts were counted on the plot and an acre like this, at 11 cents a post, would have $350 worth of material. This knoll was a part of a cornfield 22 years before the trees were cut, and had been abandoned and given over to whatever nature would put upon it. In the 22 years no expense whatever was put upon the plot, but it furnished enough fine raspberries each year to supply the owner's family. The $350 divided by 22 gives nearly $16 for the annual production per acre on this abandoned clay knoll.

It must not be understood that this is an average production, but still it shows the possibilities of the locust when the stand is complete on soil and under conditions that suit the tree. There are

numerous other acres on this same farm just as favorable to the growth of locust trees as this one, which have produced nothing in the same 22 years simply because neither nature nor man planted anything profitable on them.

The Forestry Department of the Experiment Station has made numerous estimates on locust groves in different localities of the State, some of which groves have been marketed. The most of these, by counting posts at 10 cents for firsts and 6 cents for seconds, have shown an annual increment of from $8 to $15 per acre.

The seed and seedlings.—Seed should be soaked in hot water preparatory to planting. An hour or two is sufficient, and the water may be near the boiling point at the time of first application, but if other applications are made the temperature should not be as high. Seed planted without this preparation will frequently not give satisfaction.

Under ordinary circumstances the seedlings are ready for use at 1 year old and should not be carried over to a second year. After the first year the roots of the locust stretch out to great lengths in the soil; and when a tree 2 years old or more is removed for transplanting the fibrous roots will be left behind in the soil where they will be a nuisance in the future, and the removed tree sustains a loss from their being left behind. A 1-year-old seedling locust 18 inches tall is worth more for transplanting than one that is 2 or 3 years old and 8 or 10 feet tall.

Distance to plant.—Locusts may be set the same distances as most other species—that is, about 6 by 7 feet or 5 by 8 feet, thus putting about 1,000 trees per acre. If considerable areas, however, are to be planted, the sprouting tendency of the tree may be used to advantage. The trees may be set only one-half or even one-third as thick. After they have stood thus for 2 or 3 years, a colter or narrow plow run through in both directions between the rows will cause sprouts to spring up from the disturbed roots sufficient to make the stand complete. Where it is desired to maintain the original rows, it would not be well to use this method, as it will give the grove a promiscuous appearance.

Any locust grove, after the first crop of trees is taken off will take on a somewhat irregular and promiscuous appearance unless the sprouts between the rows are kept down. In case of small groves where the owner may wish to retain the original symmetry, these sprouts may be controlled by slight pasturing after the trees reach a diameter of 3 inches or more. If such pasturing be done it should be allowed only in sufficient quantity to destroy the sprouts.

NITRIFICATION

E. R. ALLEN

Nitrification in its broad sense includes those biological processes in the soil which deal with the transformation of nitrogen from the organic form, as found in plants and animals, into the form of nitrates. This process takes place in three steps: first, the organic matter is broken down with the formation of ammonia; next, the ammonia is converted into nitrite; and as a final step, the nitrite is transformed into nitrate. The last two steps constitute nitrification in the restricted sense, while the first step is then designated as ammonification.

An idea which was prevalent for years among investigators was that only the nitrate nitrogen could be utilized by growing plants, and that therefore nitrification was indispensable to agriculture unless heavy fertilization with the expensive nitrate fertilizers was practiced. This idea was strengthened by the large number of studies on nitrification and the nitrate content of soils, which indicated as a general rule that strong nitrification in soils was correlated with high fertility. Recent work, however, has brought out two rather interesting points: first, plants can apparently use nitrogen to a very considerable extent in both the organic and ammonia forms; and, second, the relation between nitrification and crop production is, in some cases, even closer than was formerly supposed. Cases have also been reported where there was no apparent relation between nitrification and plant growth. It thus seems that, despite the fact that the process has been studied for more than 25 years, its role in soil fertility is as yet not clearly understood.

Studies which have been made on the plots of the Ohio Station illustrate some of the relations that may be found between nitrification and fertility. In samples taken from the continuous culture plots there appeared to be a very close relation between nitrification and crop production; however, in those taken from the barnyard manure series in the 3-year rotation consisting of corn, wheat and clover there was no consistent relation. The results in the one case were just as striking as in the other. This indicates that the factors which limit crop production in the continuous culture plots are not the same as those which exert a controlling influence in the barnyard manure series. The results justify some consideration with regard to what the nature of the factor or factors

is in the continuous culture plots. Careful analyses of these results and of the treatment of the different series of plots suggested quite strongly to us that the lack of available nitrogenous material is the cause of decline of yield and of nitrifying power on the check plots of the continuous culture series. The one great difference between the checks of the continuous culture and the barnyard manure plots is that the latter are grown to a legume every third year, thus adding nitrifiable material to the soil. This acts as food for the nitrifying bacteria, and therefore maintains the nitrifying power of these plots. In the checks of the continuous culture plots, on the other hand, no nitrifiable material has been added for 20 years, and the continuous cropping has tended to remove nearly all that portion of the soil nitrogen which is capable of being nitrified, and a dying off of the nitrifying bacteria results. All the fertilized plots of the continuous culture series receive regularly additions of nitrogen in one form or another, and this either is nitrifiable material or is transformed into it.

It seems that the easiest explanation of a lack of nitrifying power in the check plots of the continuous culture series is that the nitrifying flora have died off because of lack of nitrifiable material as food. It is interesting to note in this connection that the New Jersey Experiment Station has found that the introduction of a legume catch crop into continuous culture experiments produced decided improvement in yields. Indeed, the leguminous catch crops more than doubled the yield of wheat and rye as compared with the plots upon which no such catch crops were grown. Thus it seems that the low yields and low nitrifying powers of the check plots of the continuous culture series are due to nitrogen hunger. This suggested explanation is of considerable interest, since continuous growing of any one plant has been recognized as detrimental to that plant and sure to be associated with declining yields. Despite the fact that scientists have studied the phenomenon of continuous culture very extensively, a satisfactory explanation for its deleterious effects have not yet been found. If the study of nitrification will throw any light on the subject, it will be worthy of our best efforts.

Before these provisional conclusions and suggestions can be placed in the class of facts established beyond any reasonable doubt, much rigid research must be performed. The nitrifying bacteria will have to be isolated and grown in pure culture in the laboratory under controlled conditions, and much more refined and accurate methods for the determination of the different forms of nitrogen will be necessary.

CONSERVATION OF POTASSIUM

J. W. AMES

The bulk of the potassium salts used in fertilizers and for other industrial purposes have come from the famous Stassfurt deposits in Germany. Statistics show that under normal conditions in 1913 approximately $125,280,000 worth of commercial fertilizers was used in the United States. Of this amount $20,450,000 was spent for potassium salts. The quantity of the several potassium salts used in commercial fertilizers and retail prices paid are:

	Tons	Value
Muriate of potash	225,366	$9,916,000
Sulphate of potash	47,874	2,872,000
Kainit	466,695	5,601,000
Manure salts	171,802	2,061,000

The following figures show the repaid increase in price of muriate of potash from $40 a ton previous to August, 1914:

	Price per ton
January 1, 1915	$ 62.50
February 28, 1915	114.00
June 30, 1915	225.00
October 30, 1915	260.00
November 30, 1915	425.00
December 31, 1915	480-500

Practically no muriate of potash at the present high price enters into commercial fertilizers, purchases at this price being mostly for chemical industries.

At the outbreak of hostilities in Europe the German government placed an embargo on the exportation of potash. Since then the supply has been cut off, and this shortage of potassium has caused interest to be taken in the development of supplies in the United States. The possible sources of potassium being investigated are saline residues, alunite deposits in Utah containing about 9 percent potassium, potassium-bearing feldspars, green sand marls found in New Jersey, Kentucky and other states, kelp beds of the Pacific coast, and other organic sources including molasses residues, wool scourings and the like. It will be sometime, however, before sufficient potassium will be produced from these sources to meet the demand.

If more attention were given to the utilization of the supply in the soil, and the conservation of organic residues and manure, both of which contain available potassium, a shortage of German potash would not cause any alarm now nor in the future.

SOIL SUPPLY

In the first place, the soil has a large content of potassium, although much of this is now unavailable. The average quantity of potassium found in Ohio soils used for general farm crops varies from 20,000 pounds in light sandy soils to 50,000 pounds per acre in clay loams and clays. These amounts are in the surface 7 inches. The subsoil from a depth of 7 to 15 inches contains from 2,000 to 10,000 pounds more than the surface soil. Peat or muck soils contain much less than soils of mineral origin. The average amount found in this class of soils is about 3,000 pounds per acre 7 inches.

Only a very small part of the mineral supply of potassium is soluble in water; and, if the same measure of availability that is used for potassium in commercial fertilizer salts—determination of the water-soluble content—is applied to soils, practically none of it can be considered available. Although laboratory methods do not indicate that any of this potassium is available, considerable quantities are liberated for the needs of crops by the right system of soil management, which includes the proper use of nitrogen and phosphorus fertilizer, liming the soil when necessary and returning all crop residues, manure and other organic materials available.

Liberation by fertilizers and lime.—Statements concerning the liberation of potassium directly by acid phosphate and nitrate of soda have been made in advertising literature of fertilizer companies. While there may be to a slight extent some increased availability due to interaction of added fertilizer salts and potassium compounds in the soil, the liberation of potassium is chiefly through the medium of plant growth; for, when deficiencies in available phosphorus and nitrogen are met, plants are more able to forage for and utilize potassium in the soil.

It has often been said that lime liberates potassium from potassium-bearing minerals. No conclusive evidence has been secured as to how and to what extent this action takes place. It is certain, however, that liming the soil makes conditions more favorable for plant growth. The legumes, which are especially sensitive to deficiencies of lime, assimilate large amounts of potassium.

Liberation by organic matter.—Water containing carbon dioxide is an active solvent of minerals in the soil. The carbon dioxide and organic acids resulting from the decomposition of organic matter incorporated with the soil increase the availability of potassium. Plant remains, in addition to supplying organic matter, contain fertilizing elements which have a value comparable with the same elements in commercial fertilizers.

Organic matter, phosphorus and lime increase the activities of soil organisms which produce carbon dioxide and assist in decomposing insoluble potassium silicate.

CROP RESIDUES

Moreover, the organic remains of crops when returned to the soil furnish considerable potassium. The following figures based on the composition of crops which have been analyzed at the Ohio Station furnish information concerning the quantities of potassium released from the soil and stored in the different parts of the plant. Attention is directed to the amount of potassium as compared with phosphorus and nitrogen in that part of the plant which should, under ordinnary conditions, be returned to the soil either directly or through the manure produced.

TABLE I.—Fertility elements in ordinary farm crops

Crop		Potassium	Phosphorus	Nitrogen
		Pounds	Pounds	Pounds
Wheat	20 bushels	4.25	4.18	23.70
Wheat straw	2,000 pounds	16.61	1.82	10.56
Oats	45 bushels	8.34	5.89	28.97
Oat straw	2,000 pounds	21.89	1.75	11.62
Corn	42 bushels	8.00	5.63	41.35
Corncob	600 pounds	3.84	.156	3.00
Corn stover	2,000 pounds	15.59	1.33	16.28
Timothy hay	2,000 pounds	26.73	2.62	16.82
Clover hay	2,000 pounds	22.48	3.66	43.34
Alfalfa	2,000 pounds	33.20	5.80	50.20
Soybeans	14 bushels	15.70	5.27	45.61
Soybean hay	2,000 pounds	13.62	1.37	40.00
Potatoes	62 bushels	17.89	2.60	12.60
Potato tops*	2,000 pounds	23.20	1.06	25.20
Tobacco leaves	2,000 pounds	40.80	3.93	60.00
Tobacco stems	500 pounds	32.00	1.50	12.50
Tobacco stalks	2,000 pounds	66.00	4.40	50.00

*30 percent water.

POTASSIUM CONTENT OF MANURE

The last and most important supply of potassium on the farm is barnyard manure, the losses from which amount to far more than the elements bought in commercial fertilizers. Potassium in manure is practically all water-soluble and is as efficient as that supplied by potassium salts in fertilizers. From the following figures, based on analyses made at the Ohio Station, it will be seen that a large part of the potassium is contained in the liquid excrement. The potassium in the solid excrement is also readily soluble in water.

TABLE II.—Fertility elements in the solid and liquid excrement of farm animals

Class of livestock	Annual production for 1,000 pounds live weight (pounds)		Fertility elements (pounds)					
			Potassium		Phosphorus		Nitrogen	
	Solid	Liquid	Solid	Liquid	Solid	Liquid	Solid	Liquid
Horse	14,000	4,000	28	50	18	.....	69	48
Cow	18,000	8,000	10	90	13	.....	79	84
Sheep	8,000	4,000	20	70	16	1	52	67
Hog	18,000	12,000	66	56	36	6	108	36
Poultry	8,000	.....	24	.....	32	.....	64	.....

Experiments conducted at the Ohio Station for a period of 5 years show that during 3 months, from January to April, manure exposed in 1,000-pound piles lost 50 percent of its potassium. At the same time there was considerable loss of nitrogen and phosphorus as indicated in Table III.

TABLE III.—Fertility elements in a ton of manure before and after exposure for 3 months

Kind of manure	Potassium		Phosphorus		Nitrogen	
	Total	Soluble	Total	Soluble	Total	Soluble
Fresh.....pounds..	11.19	10.51	2.36	1.20	13.53	6.17
Exposed.....do....	5.48	5.05	1.83	.93	8.73	2.53
Loss.....percent..	51.02	51.95	22.46	22.50	35.63	59.00

In 1913 the quantity of commercial fertilizer used in Ohio amounted to 180,000 tons. Assuming that this averaged 1 percent actual potassium, the amount used in fertilizers would be about 2,000 tons, equivalent to 4,000 tons of muriate of potash.

A ton of farm manure contains 10 pounds of potassium, and 10,000,000 tons is a conservative estimate of the amount of manure produced in Ohio by 690,000 horses and 1,290,000 cattle during the winter months. This amount of manure would furnish 50,000 tons of potassium, which is 25 times the quantity of potassium used in commercial fertilizers according to statistics for 1913; and, at the price ($50 per ton) for muriate of potash previous to 1915, it would be worth $5,000,000. If one-fourth of this quantity of potassium is lost by careless handling of the manure, it would amount to more than six times the potassium purchased in commercial fertilizers.

The conservation of this source of potassium, as well as that of crop residues and the liberation of this element already in the soil, should command the attention of every farmer.

SHALL WE FERTILIZE CORN IN THE HILL?

C. E. THORNE

The high price of fertilizers this season will probably tempt many farmers to adopt the practice, which is already followed to a considerable extent, of limiting the dose of fertilizer for the corn crop to a spoonful or so applied in the hill; but there are good grounds on which to question the economy of such a practice. It is quite probable that hill fertilizing, if all the conditions are favorable, may start the young plant off at a more rapid pace, but it is the endurance to the finish that counts in corn growing, as well as in horse racing.

My earlier years were spent on a flat farm in southwestern Ohio; and one of my afflictions as a plowboy was that the double shovel, which was the ordinary implement of cultivation in those days, would cover up the little corn on the clay knolls long after the corn was a foot or more high in the black sloughs between. When the harvest came the black-land shocks contained much more corn than those grown on the clay. Fertilizers were unheard of in those days, but my father began spreading the manure of the farm all on the clay knolls, assuming that the black land would take care of itself. The result was that within a few years the clay land was producing one-half more corn than the black land, although the early growth on the clay was still considerably smaller than that on the black land.

A study of the plant's method of feeding will explain such conditions as I observed on this farm. Farmers think that if the plant has a vigorous start it will push out its roots later in the season and thus gather in more sustenance. I know of no evidence that the plant feeds in this way. It is the food in front that attracts the roots, provided there is always an unbroken connection with the stalk; they are not shoved forward by the plant except to a very limited extent. I have traced a main root of an elm tree for 40 feet under a rotten log; the root followed the log without any deviation to right or left.

The tip end of the root is a very minute cell, through the walls of which the nutrient solution in the soil is absorbed. If the cell finds nutriment it divides by building a wall across its middle and pushing the new cell thus formed a microscopic distance forward. In abundance of food this process goes forward rapidly; if food is scarce it moves more slowly; and in the absence of food it ceases

altogether. To feed a big cornstalk many myriads of these cells are at work. They can no more perform their full office around a single spoonful of fertilizer than can a swarm of bees fill their hive from one clover blosom, even though that blossom stood in an inexhaustible fountain of nectar.

Moreover, there is extremely little lateral movement of plant food in the soil, as any farmer will realize who observes the small spots in a field of oats, growing after corn that has been fertilized in the hill.

Another reason for scattering the fertilizer over the entire surface of the ground is that the crop immediately fertilized never consumes all the plant food given, but a considerable part is carried over for the feeding of subsequent crops. In the 5-year rotations of wheat, clover, timothy, corn and oats, which the Ohio Experiment Station began at Wooster in 1894 and at Strongsville a year later, one plot (No. 15) has been fertilized only on the wheat crop. The average increase of wheat has been 13.7 bushels at Wooster for 20 years and 8 bushels at Strongsville for 15 years, as reported up to 1913 in Circular 144. This has been followed at Wooster by an increase of 749 pounds of clover hay, 401 pounds of timothy, 7.4 bushels of corn and 3.6 bushels of oats, and at Strongsville by 868 pounds of clover hay, 469 pounds of timothy and 2.6 bushels of corn, with an apparent loss of 3 bushels of oats. Valuing wheat at 90 cents per bushel, corn at half a dollar, oats at one-third of a dollar and hay at $10 per ton, the increase of wheat has been worth $12.33 at Wooster and $7.20 at Strongsville, and the residual gain for the other four crops has been worth $10.65 at Wooster and $6.98 at Strongsville. The value carried over has therefore been 86 percent of that realized in the fertilized crops at Wooster and 97 percent at Strongsville.

No argument should be needed to convince the observing farmer that it would require a much longer time than 4 years to realize this residual value of the fertilizer, if dropped a spoonful every 3½ feet, where it would be practically out of reach of 99 plants out of every 100 of the small grains and grasses which follow the corn in systematic rotation on every wisely managed farm.

RECENT TECHNICAL BULLETINS

The following bulletins in the "Technical Series" may be obtained by writing to the Experiment Station, Wooster:

No. 290—Varieties of Apples in Ohio.
" 291—Experiments with Laying Hens.
" 292—Sulphur in Relation to Soils and Crops.
" 293—The Grape-Berry Worm.

NOTICE

CHANGE IN FORM OF PUBLICATION

In order to carry the results of the work of the Ohio Experiment Station more promptly and in more practical form to the farmers of the State, and to place the scientific phases of this work in a form more useful to teachers and scientific investigators, it has been decided to issue the publications of the Station in two series; namely:

1. A series of "Technical Bulletins," which will be a continuation of the regular series heretofore issued, but which will hereafter be limited in scope to a technical record of the Station's investigations and will be distributed only to libraries and to such persons as may especially request them. This series will also serve the purpose of the former "Technical Series," of which eight numbers have been published, and which will now be discontinued.

2. A "Monthly Bulletin," which will be published as a monthly journal, each number containing several brief, nontechnical and timely reports of progress on different phases of the Station's work, written for the purpose of illustrating the practical application of this work to the agricultural conditions of Ohio. This Monthly Bulletin, in respect to distribution, will take the place of the Bulletins and Circulars heretofore issued. It will be sent free to the Station's present mailing list without further request, and to any others who may ask for it, but the "Technical Bulletins" will be sent only on special request. These bulletins will be advertised, when issued, in the Monthly Bulletin.

All communications should be addressed to

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Wooster, Ohio.